

## Fruit as a winter feeding resource in the diet of Stone marten (*Martes foina*) in east-central Italy

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### Abstract

The present study was carried out in Le Cesane (east-central Italy) during the winter of 1992. The environment is a mosaic of woodland (mostly conifer plantations), sown and uncultivated lands. A total of 89 scats of stone marten *Martes foina* was collected. Standard techniques were applied for analysing the content of scats. Diet composition is given as percentage of occurrence and percentage of estimated volume. The winter diet of the stone marten is almost completely frugivorous. The fruit represents 89% of the total volume in the diet with a percentage of occurrence of 55%. Wild fruits are the most common food items. Berries from juniperus (*Juniperus* sp.) and from sloe (*Prunus spinosa*) are the most important feeding resource (42.2% and 29.7%, respectively). A significant relationship has been found between latitude and winter consumption of fruit in Europe. A trend of increasing consumption of winter fruit has been detected from northern to southern Europe.

### Introduction

Numerous studies have been carried out in Europe on the diet of the stone marten *Martes foina* Erxleben, 1777 in rural environments (e.g. WAECHTER 1975; DELIBES 1978; AMORES 1980; MARCHESI et al. 1989; RASMUSSEN and MADSEN 1985; SKIRNISSON 1986; TESTER 1986; CHEYLAN and BAYLE 1988; ROMANOWSKI and LESINSKI 1991; RUIZ-OLMO and PALAZON 1993; LODE 1994). The feeding habits of this mustelid in the Italian peninsula are still poorly known (POZIO and GRADONI 1981; BERTOLINO and DORE 1991; SERAFINI and LOVARI 1993). According to these authors the stone marten is omnivorous and feeds on mammals, birds, reptiles, amphibians, insects and fruit. Fruit shows a high incidence in the diet of this predator mainly in Mediterranean and temperate habitats (WAECHTER 1975; SKIRNISSON 1986; BERTOLINO and DORE 1991; RUIZ-OLMO and PALAZON 1993; SERAFINI and LOVARI 1993; LODE 1994). The geographic variation in the consumption of fruit might be related to geographical factors, among which latitude (which clearly influences the local availability of fruit throughout the year in different habitats) plays a major role. This condition of a higher fruit consumption at lower latitudes may correlate closely with the notion of the stone marten as an opportunistic predator, whose diet is determined by local availability of feeding resources (CLEVENGER 1994).

The aim of this study is twofold: 1) to report data on the winter food of the stone marten in east-central Italy, focussing on an analysis of the consumption of wild and cultivated fruit; 2) to test the hypothesis that geographic variation in winter consumption of fruit in Europe may be related to latitudinal changes.

## Material and methods

The study was carried out in the Cesane State Forest, located in the Marche region of east-central Italy (43° 43' N 0° 13' E), between 150 and 648 m altitude. The climate is mediterranean. Average monthly temperature varies between 4 °C in January and 25 °C in July; the mean annual rainfall is 900 mm. Pine plantations cover most of the study area. *Pinus nigra*, *P. pinea*, *P. halepensis*, *P. maritima* are the main species used in reforestation. Cedars (*Cedrus atlantica* and *C. deodara*) and cypresses (*Cupressus sempervirens* and *C. arizonica*) are scattered in the pine plantations. The remaining part of the study area is covered by mixed deciduous formations of *Quercus pubescens*, *Ostrya carpinifolia*, *Fraxinus ornus*, *Acer opalus* and *Corylus avellana*. Sown and uncultivated fields are interspersed within the woodland and cover only a few hectares.

The occurrence of the pine marten *Martes martes* has not been recorded in the present study area, thus avoiding the possibility of collecting scats of pine marten by mistake instead of those of stone marten.

A total of 89 scats was collected every fortnight in January and February, 1992. The sample was analysed according to conventional methods (KORSCHGEN 1980). The different prey items were determined by macroscopical and microscopical analyses and compared with our reference collections. The results are given as relative percentage of occurrence (number of each food item/total number of food items). The percentage of estimated volume (KRUK and PARISH 1981) of each food item in the diet was calculated on 70 scats.

In order to assess geographical variation in winter consumption of fruit in Europe, data were collected from 8 studies relative to the diet of the stone marten: CLEMENT and SAINT GIRONS 1982; SKIRNISON 1986; TESTER 1986; MARCHESI et al. 1989; BERTOLINO and DORE 1991; RUIZ-OLMO and PALAZON 1993; SERAFINI and LOVARI 1993; LODE 1994. The number of studies reviewed is not high, since only studies carried out in winter (January, February, and March) and in rural habitats have been considered. The arcsin-transformed percentage of occurrence for different values of n (FREEMAN and TUKEY 1950) was regressed against latitude of the different study areas.

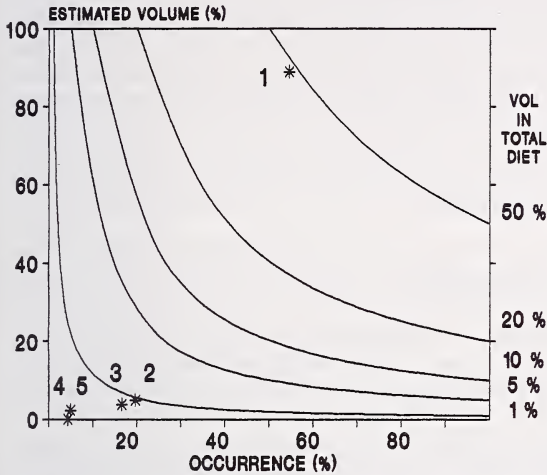
**Table 1.** Percentage of occurrence, number of each food item/total number of food items, in 89 scats of stone marten. N = number of occurrence.

Food category	N	%
Fruit	121	55
Wild fruit/seeds	100	82.6
<i>Juniperus</i> sp.	51	42.2
<i>Prunus spinosa</i>	36	29.7
<i>Sorbus domestica</i>	5	4.1
<i>Rosa canina</i>	4	3.3
<i>Clematis vitalba</i>	2	1.7
<i>Crataegus monogyna</i>	1	0.8
<i>Cornus mas</i>	1	0.8
Cultivated fruit	13	10.8
<i>Vitis vinifera</i>	7	5.8
<i>Ficus carica</i>	3	2.5
<i>Pyrus communis</i>	2	1.7
<i>Malus sylvestris</i>	1	0.8
Unidentified fruit/seeds	8	6.6
Mammals	41	18.6
Birds	9	4.1
Insects	37	16.8
Unidentified material	12	5.5
Total items	220	

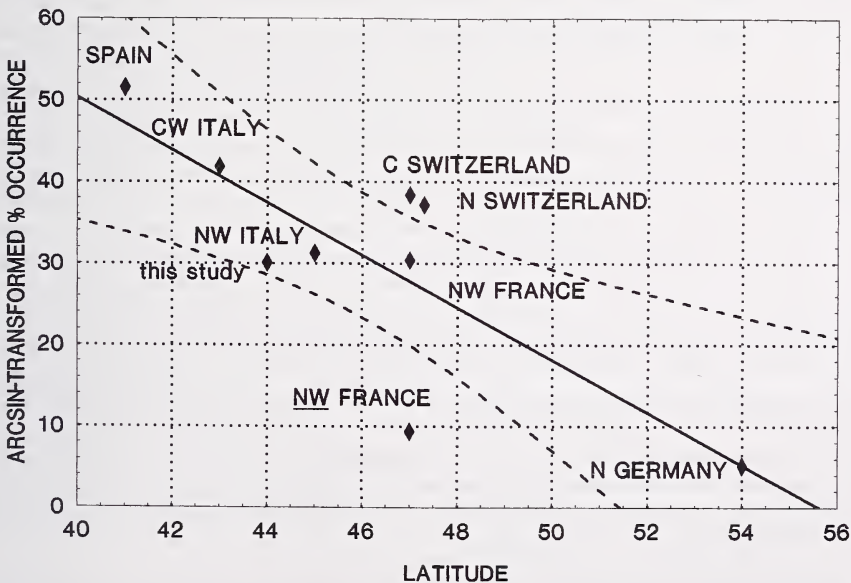
**Results**

The categories of prey found in stone marten faeces included fruit, mammals, birds, and insects (Tab. 1). Fruit was the most common item occurring in 55% of the samples, with

89% volume (Fig. 1). Eleven species were identified, four of them being cultivated. The berries from juniper (*Juniperus communis* vel *oxycedrus*) play an important role in the winter food of stone martens and represent the most frequently consumed fruit. They occur in 42.2% of the samples and are followed in importance by sloe, *Prunus spinosa* (29.7%) (Tab.1). The remaining 9 species of fruit occur in 21.5% of the samples. *Clematis vitalba* has nonsucculent seeds and thus cannot be considered palatable for the stone marten. The seeds may have been swallowed by chance during hunting activities of this mustelid. From a total number of 121 only 13 (10.8%) corresponded to cultivated fruits:



**Fig. 1.** Estimated volume of food categories versus their percentage of occurrence in 70 scats of stone marten. 1: fruit; 2: mammals; 3: insects; 4: birds; 5: unidentified material.



**Fig. 2.** Relationship between winter consumption of fruit and latitude in the diet of the stone marten in Europe. Arcsin-transformed percentage of occurrence for different values of n (FREEMAN and TUKEY 1950). NW Italy (BERTOLINO and DORE 1991); CW Italy (SERAFINI and LOVARI 1993); Spain (RUIZ-OLMO and PALAZON 1993); NW France (CLEMENT and SAINT GIRONS 1982); NW France (LODE 1994); C Switzerland (MARCHESI et al. 1989); N Switzerland (TESTER 1986); N Germany (SKIRNISSON 1986).

apples, pears, figs and grapes. Mammals and insects represented less used food resources and constituted 18.6% and 16.8% of the sample, respectively. These feeding categories have a very slight incidence in the total volume of the diet (Fig. 1). Birds are only occasionally taken.

Figure 2 depicts the regression of winter consumption of fruit in Europe against latitude. A significant relationship has been found ( $r = 0.795$ ;  $F = 12.03$ ;  $P = 0.01$ ) suggesting that stone marten feeds more on fruits in southern Europe than in the north. The figure shows NW France separated from the other areas. The study area in NW France is located in marshy habitat (Lake Grand-Lieu close to Nantes), where the fruit availability may be lower than the expected value.

## Discussion

The stone marten reveals the most frugivorous diet among the European species of mustelids (WEBER 1989; CLEVINGER 1994). This predator exploits fruits found on the ground but also may have access to those still on trees (WAECHTER 1975). The climbing ability of this carnivore may have determined this food selection (TESTER 1986; SERAFINI and LOVARI 1993). Fruits are rich in carbohydrates and do not require any special adaptation to be digested and can represent an alternative feeding resource in the cold months when the energy requirements are higher.

Wild fruit such as berries from juniper and sloe are the staple winter food of the stone marten in the study area. Juniper usually represents the most frequent food item in Mediterranean habitats (LIBOIS 1991) and its berries are in general replaced by Rosaceae fruit in temperate habitats (LIBOIS 1991). In east-central Italy cultivated fruit represents a feeding resource of secondary importance. Elsewhere in Europe cultivated fruit, such as grapes or cherries, are often consumed (WAECHTER 1975; RUIZ-OLMO and PALAZON 1993).

The high incidence of fruit in the winter diet of this mustelid in east-central Italy may be related to habitat characteristics. Succulent fruit are very abundant and with a clumped distribution in the study area. The low incidence of small mammals recorded in the diet of stone marten in this study could be due to the relative scarcity of this food item in the study area. Monocultures of exotic conifers in the Cesane state forest are probably associated with lower diversity and availability of alternative prey (e.g. non arboreal small mammals). A combination of reasons (the availability of fruit and seeds and the scarcity of small mammals) may explain why the stone marten diet can be based so extensively on vegetable matter in east-central Italy. These results concern, however only two months in one single winter. Differences in the stone marten diet could be recorded from year to year in relation to differences in the availability of feeding resources (KALPERS 1980). Therefore, these results could not be considered conclusive. Nevertheless, they seem to confirm the general trend detected in Europe in winter consumption of fruit. The high geographic variability observed in the studies considered seems to be related to latitude. A significant trend in the form of an increase in winter consumption of fruit has been found from northern to southern Europe. The results suggest that where the habitat and climate allow for readily accessible fruit, this food item represents a very common dietary resource (e.g. southern Europe). Also, it is evident that the stone marten can switch to different feeding resources in relation to local and temporal food availability (LODE 1994), thus confirming the view of an opportunistic feeding behaviour of this species.

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## Zusammenfassung

### *Früchte als Winternahrung des Steinmarders Martes foina in Mittel-Ost-Italien*

Diese Studie basiert auf einer Analyse von Kotproben aus dem Winter 1992 in Le Cesane (Mittel-Ost-Italien). Das Habitat besteht aus einem Gemisch von Waldflächen (hauptsächlich aus aufgeforsteten Koniferen), Acker- und Brachland. 89 Kotproben von *Martes foina* wurden gesammelt und nach Standardmethode analysiert. Die Zusammensetzung der Nahrungskomponenten ist prozentual auf den zahlenmäßigen Anteil und das abgeschätzte Volumen kalkuliert worden. Die Winterdiät des Steinmarders besteht hauptsächlich aus Früchten. Diese stellen zahlenmäßig einen Anteil von 55% und volumemäßig einen Anteil von 89% der Gesamtmasse dar. Wildfrüchte sind somit die häufigste Nahrungskategorie. *Juniperus* sp. und *Prunus spinosa* Beeren sind die wichtigste Nahrungsquelle (mit 42,2% bzw. 29,7%). Breitengrad und Winterfruchtverbrauch sind in Europa signifikant korreliert. Die steigende Tendenz von Früchtekonsum in der Winternahrung verläuft in Europa von Norden nach Süden.

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